miles from northwest to southeast through our State. It is impossible to confound this storm with the tornado, which is fortunately very restricted in its field, mowing a swath of destruction, generally, in a direction corresponding to the line of the squall storm front, from a southwesterly toward a northeasterly point. The tornado is narrow, local; the squall at a given instant reaches a narrow, long-extended belt of land like a tornado track, but this belt of destruction is carried forward with great velocity so as gradually to sweep over a large part of the State. Again, the squall of summer is radically different from the blizzard of winter. The squall comes, reaches us, and after a few minutes leaves us, moving onward in its general course toward the southeast; the blizzard blows for hours, and even days. In the squall, but a limited amount of air comes down from the northwest, a great roll of cold and dense air falling upon us; in the blizzard, the entire atmosphere covering several States is moving as one body toward the southeast."

* * * * * * *

Three cases are mentioned of dead horses found at the barbed wire fence. I would like references to similar cases elsewhere.

The barbed wire fence, which has spread so widely since 1875, has come to be recognized as a dangerous form of lightning conductor, and the injuries to cattle are innumerable; but we believe it has been abundantly shown that the danger is entirely dissipated if only the posts to which the fence is attached are properly connected by a wire to a moist soil below. In this way every post becomes a conductor, instead of an insulator, and the electricity is carried safely below.

The distinction between the destructive winds of a tornado, a hurricane, a blizzard, a straight-line squall or derecho, as it is called by Hinrichs, or the vents de grains, as they are called by Durand-Gréville, is important for several reasons. The insurance companies, if policies specify insurance against tornadoes, are very likely to evade payment if it can be shown that the destructive wind belonged to the squall or some other class, so that farmers would do well to see to it that when they insure against damage by lightning, rain, hail, winds, etc., the policy shall say just that and no more, omitting all reference to tornadoes, squalls, cyclones, hurricanes, etc.

CLIMATOLOGY OF SPRINGFIELD, MO.

By N. R. TAYLOR.

Springfield, Mo., latitude 37° 12′ north, and longitude 93° 18′ west, is situated near the center of Greene County, of which it is the seat of justice, and is located in that part of the State popularly known as "Southwest Missouri". It is about 90 miles east of the point where Kansas and the Indian Territory touch the State of Missouri, and about 60 miles north of the Arkansas line. It is 239 miles southwest of St. Louis, and 194 miles southeast of Kansas City.

As regards topography, the city lies near the center of an extensive section known as the "Ozark Plateau", which is a culmination of the gradual rise that begins south of the Missouri River and ends in the northern portion of Arkansas. This plateau slowly decreases in height and rapidly increases in ruggedness as the border of Arkansas is approached.

"The great watershed of the Ozark uplift, which is, in general, followed by the St. Louis and San Francisco railroad, divides the district into two slopes. The waters on the north flow into the Missouri; those on the south into the White River".[1]

The site of the city itself, is, on the whole, level, the only exception being a narrow and shallow valley that slopes toward Wilsons Creek, a small stream running approximately westward, and roughly forming a dividing line between the northern and southern halves of the city.

In so far as tabulated data are concerned, the meteorological history of Springfield begins in 1877. In February of that year observations of temperature and rainfall were begun by Mr. A. M. Lapham, whose records extend thru 1879, except that observations of temperature were mist during the months of March, October, November, and December, 1879, and rainfall measurements were omitted in December, 1879. Observations were resumed in 1884 by Prof. E. M. Shepard, whose records of temperature extend from April of that year to June, 1887, inclusive, except the months of June and November, 1886, and whose rainfall records extend from May, 1884, to September, 1887, inclusive, except the month of June, 1886.

It is regretted that no reliable records exist for the full four years ending with 1883, as tradition recounts the occurrence of several meteorological events of more than passing interest during this period.

A record of rainfall from January, 1877 to December, 1887, inclusive, is compiled in The Report of the Missouri Rainfall, by Francis E. Nipher; but owing to the fact that the rainfall for the entire year of 1881, and for several months in other years, is interpolated, the normals being substituted for the missing data, only such records as are shown to be the result of actual observation are here quoted. A note in the publication referred to, describing the kind of rain gages used, the manner in which they are exposed, and the care with which observations were taken, is accepted as evidence of the accuracy of such of the data as appear in the accompanying table.

On September 27, 1887, an observing station was established at Springfield by the United States Government. It was then under the Signal Corps of the Army, but since June 30, 1891, has been under the Weather Bureau, Department of Agriculture. Since the establishment of this station all meteorological elements have been regularly and systematically recorded.

In addition to the tabulated matter in the accompanying tables, there are many authentic accounts of phenomenal weather conditions which have occurred in this section during its early history.

In the history of Greene County, Missouri, published by Perkins and Horne in 1883, the following notes are found:

The winter of 1834–5 was unusually cold. The "cold Friday and Saturday" will long be remembered. Cattle had their horns frozen, pigs and fowls perished in great numbers, and there was much damage done to fruit trees. The snow drifted to extraordinary depths, lying on the ground from December to March. It was impossible, in many cases, to go to mill or to a store, owing to the distance and the condition of the roads, so the hominy block was called into use to supply breadstuff, and the "store goods" were dispensed with.

In November, 1848, came the "big sleet", as it was afterwards known. The sleet began falling, and then came rain, hail, and freezing weather, alternately, until the ice covered the ground to a depth of 3 or 4 inches. Timber was broken down, and travel almost suspended.

The winter of 1855 was an exceptionally hard one in Greene County. On the 4th and 5th of February of that year the thermometer stood at 20° below zero, and the snow lay upon the ground to the unprecedented depth of from 18 to 20 inches. On the 19th of August following there was a sharp frost.

On January 23, 1856, snow fell in the county to a depth of 14 inches.

On the 25th of June, 1875, an extraordinary rainstorm visited Greene County. Every little stream became a river, and all creeks were out of bank, causing great destruction of property. Wilsons Creek in Springfield was 100 yards wide. The damage done in Springfield was at least $5000. This storm was general throughout southwest Missouri.

In July, 1876, the Pomme de Terre, a small stream that flows through the northern part of the county, was extraordinarily full on account of the freshets from heavy rains. Widespread damage occurred to farms lying along the banks of this stream. The height of the water was from 3 to 4 feet higher than it was ever known.

Reports indicate that all streams in southwest Missouri were out of bank in July, 1876. when, according to many verbal accounts from the older inhabitants, the heaviest rainfall occurred that was ever known in this section.

In a small pamphlet, entitled "Greene County, its Resources and Advantages", the following account of an exceptionally early spring is found:

In 1878, full-grown potatoes were eaten on the first day of May, and peas on the 5th. Strawberries, grown in the open air, were ripe on April the 5th. Peaches were ripe on the 15th of June, and corn on the 25th of that month.

The following is from the history of Greene Conuty:

The drought of 1881 will not soon be forgotten by the farmers of

[1] Geology of Greene County, Mo., by Prof. E. M. Shepard.

Greene County. In this county no rain fell from the middle of July until the 10th of September. Corn shriveled in the fields, and, taking the county throughout, was not one-half of an average crop. Fruit of all kinds was short, and potatoes and other root crops were almost an entire failure.

After a close examination of the history of this section since 1833, accounts of only two tornadoes have been found. One of these occurred at Marshfield, Mo., a small town about 25 miles northeast of Springfield, on April 18, 1880, and the other in the northern part of the city of Springfield on November 5, 1883. Many facts, oral and written, have been gathered relative to the Marshfield tornado, but the most reliable and scientific are contained in an article that was written by Prof. E. M. Shepard of Drury College, Springfield, Mo., and published in the Patriot Advertiser on May 6, 1880. Professor Shepard traversed a portion of the path of this storm, and his description indicates that all of the characteristics of the dreaded tornado were present during its passage thru the ill-fated town. This tornado resulted in the death of at least 100 persons and the total destruction of the town.

There are few more notable events in the history of southwest Missouri than that of the great storm of 1880.

Perhaps the most correct version of the Springfield tornado was published in the Herald of that city on November 6, 1883, which states that the track of the storm across the city averaged about one block in width and about a mile in length, and extended from Booneville and Division streets eastward to the boundary of the city, when it took a northerly course. Several lives were lost and a considerable amount of property was destroyed as a result of this storm.

As the occurrence of unusual and disastrous weather seems to have been emphasized by the early historians of this section, it is believed that an account of all such conditions since 1833 has been given in the preceding paragraphs.

All the facts to which attention has been directed indicate that the greatest amount of rain, snow, and sleet, the highest wind velocity, and the longest period of drought, have been exceeded prior to the establishment of the Weather Bureau station. There is reason to believe, however, that the absolute extremes of temperature, i. e., 106° and —29° that occurred on July 23, 1901, and February 12, 1899, respectively, have not been surpassed at any time during the fifty-four years ending with the year 1887, and that they now stand as the record for a period of nearly three-quarters of a century.

The highest temperature that has ever been recorded in the State of Missouri was 116°, and the lowest, 33° below zero. The former was observed at Marble Hill, Bollinger County, on July 22, 1901, and the latter at Sedalia, Pettis County, and Louisiana, Pike County, on January 5, 1884.

While the climate of this section, especially with respect to temperature, is essentially continental, a correlation of all the available data shows that periods of extreme heat and cold are comparatively rare and of short duration, and that their occurrence may always be attributed to what might be called accidental causes. Accepting only the ordinary variations of temperature incident to latitude and topography, and eliminating all modifying influences that are associated with the passage of barometric waves of abnormal intensity, the result would justify the obliterating from the records of all maxima of 90° and above and minima of 15° and below.

Conditions that produce sharp changes to colder weather in places that are separated from Springfield by only a few degrees often occur without materially affecting the temperature in this section. An illustration may be found in the winter anticyclones that develop in the far Northwest and follow the northern track in their drift eastward. While these storms invariably cause low temperatures in the extreme northern part of Missouri, their influence rarely extends as far south as this section of the State; and when any change to colder does result from these causes it is brought by the surface winds from the northeast after the disturbances have past east of the Mississippi Valley, and is rapidly followed by warmer weather as the winds veer southward.

The most significant conditions with respect to the cold waves that affect this section are exemplified by those anticyclones which attain their full strength east of the upper Rocky Mountain regions and move southeastward in the rear of receding areas of marked low pressure. The cold waves that occur under these circumstances are invariably severe, and level all climatic distinctions in Missouri, there being little difference between the several parts of the State in the degree of cold produced.

Cold waves may occur at any time during the five months ending with March, but are comparatively rare during November and March, and are much less intense than those of the winter months.

Since the establishment of the Weather Bureau station at Springfield there has been an average of about five cold waves per season, during which the temperature has fallen 20° or more in from twenty-four to thirty-six hours to a minimum of 20° or less in November and March, or a fall of 20° or more, during the period mentioned, to a minimum of 10° or less in December, January, and February.

The weather during the warmer months is modified to some extent by the passage of all barometric troughs and crests that move eastward from the Rocky Mountains, but is more directly influenced by those depressions and the following

TABLE 1.—*Climatological data for Springfield, Mo., based on nineteen years' Weather Bureau records, unless otherwise stated.*
(Latitude 37° 12′ north, longitude 93° 18′ west. Altitude 1324 feet.)

Months.	Temperature.															Relative humidity: mean monthly and annual.
	Means.			Extremes of monthly and annual means.		Mean of daily maxima.	Mean of daily minima.	Mean daily range.	Mean of monthly and annual extremes.		Monthly and annual extremes, with dates.					
	All records.	No. of years.	19 years, 1888–1906.	Max.	Min.				Max.	Min.	Max.	Day.	Year.	Min.	Day.	Year.
	°		°	°	°	°	°	°	°	°	°			°			%
January	31.9	24	33.2	39.4	24.4	41.7	24.7	16.9	66	— 1	74	26,30	1890	—17	24	1894	77
February	33.7	25	33.1	41.0	23.0	41.9	24.3	17.6	66	0	*76	4	1890	—29	12	1899	77
March	44.4	24	44.1	52.1	39.5	53.4	34.8	18.6	77	13	86	28	1895	3	7	1899	72
April	56.8	26	56.6	62.8	50.0	66.1	47.0	19.0	84	30	89	29	1899	22	1	1899	67
May	65.1	26	64.8	69.6	62.4	74.0	55.5	18.5	85	40	89	30	1906	32	1	1903	71
June	72.7	25	72.5	77.3	67.2	81.4	63.6	17.9	91	53	96	30	1890	46	4	1897	75
July	76.5	25	76.1	83.9	72.2	85.0	67.2	17.8	94	58	106	23	1901	53	9	1891	74
August	75.4	25	75.6	80.8	73.2	85.2	66.0	19.2	94	55	100	7	1896	44	24	1891	75
September	69.0	25	69.1	75.8	63.4	78.6	59.6	19.0	91	42	102	14	1893	†37	30	1895	74
October	57.8	25	58.1	65.8	53.0	68.0	48.2	19.8	84	32	90	5	1897	21	30	1887	70
November	45.4	24	45.2	51.1	41.0	54.0	36.5	17.5	74	18	79	5	1888	6	22	1898	72
December	36.3	25	37.0	51.8	31.3	44.8	29.2	15.7	64	6	74	25	1889	—11	20	1901	77
Year	55.4	.....	55.4	56.9	53.6	64.5	46.4	18.2	96	— 7	106	July 23	1901	—29	Feb. 12	1899	73

* Also on February 28, 1894.

† Also on September 30, 1899.

TABLE 2.—*Climatological data for Springfield, Mo., based on nineteen years' Weather Bureau records, unless otherwise stated.*
(Latitude 37° 12′ north, longitude 93° 18′ west. Altitude 1324 feet.)

Months.	Precipitation.									Snow.		Cloudiness.					Wind.				Average number of thunderstorms.
	Average.			Monthly and annual extremes (all records).		Greatest 24-hour fall.	Average number of rainy days.	Greatest number of consecutive days with—		Average.	Greatest 24-hour fall.	Average, 0—10.	Average number of days—			Total number of fogs.	Prevailing direction.	Average velocity.	Maximum velocity.		
	All records.	No. of years.	19 years, 1888–1906.	Max.	Min.			Rain.	Drought.				Clear, 0—3.	Partly cloudy, 4—7.	Cloudy, 8—10.				Velocity.	Direction.	
	Inches.		*Inches.*	*Inches.*	*Inches.*	*Ins.*				*Ins.*	*Ins.*	*Ins.*						*M.p.h*	*M.p.h.*		
January	2.50	24	2.59	6.47	0.34	4.64	9	5	19	5.3	10.0	5.1	11	9	11	31	se.	10.9	54	w.	1
February	2.44	25	2.42	5.22	0.81	1.86	10	8	9	4.7	7.5	5.4	10	8	10	13	se.	11.4	48	sw.	1
March	3.82	25	4.11	9.05	1.13	3.33	11	7	13	1.8	5.0	5.4	11	10	10	23	se.	12.4	60	nw.	4
April	4.00	25	3.69	8.32	1.10	1.86	11	7	12	0.3	1.6	4.7	11	11	8	7	se.	12.0	54	w.	6
May	5.61	26	5.73	11.75	2.48	3.70	12	7	16	0	0	4.6	11	13	7	12	s.	10.0	60	nw.	9
June	5.53	25	5.09	15.20	1.33	3.40	11	7	13	0	0	4.3	11	15	4	8	se.	8.2	63	nw.	10
July	4.77	26	4.77	13.12	0.50	4.81	10	8	16	0	0	4.1	12	15	4	3	s.	7.7	48	nw.	10
August	4.15	26	4.17	8.21	0.75	3.20	8	8	21	0	0	3.6	16	12	3	11	se.	7.4	48	n.	9
September	3.57	26	3.73	8.52	0.37	3.90	9	8	15	0	0	3.7	16	9	5	13	se.	10.1	48	nw.	4
October	2.75	26	2.79	9.75	0.40	2.74	7	6	19	0.1	1.0	3.5	18	8	5	20	se.	9.8	42	s.	2
November	2.71	26	2.59	5.68	0.22	2.58	8	7	22	0.7	3.0	4.9	12	8	10	13	se.	10.9	48	nw.	2
December	2.65	25	2.50	11.02	0.63	4.96	8	6	16	3.0	10.0	5.3	11	9	11	18	se.	10.9	44	se.	1
Year	44.50	.....	44.13	61.00	31.72	4.96	114	8	22	15.9	10.0	4.5	150	127	88	172	se.	10.1	63	nw.	59

TABLE 3.—*Dates of extreme temperatures for period January 1, 1888, to December 31, 1906.*

Year.	Minimum below 0°.	Maximum 95° or above.
1888	January 13–16	July 29–31; August 1, 2.
1889	None	None.
1890	February 28	June 30; July 7.
1891	None	None.
1892	January 19, 20; December 26, 27	July 22; August 7, 8.
1893	January 13, 15; February 7	July 28, 30; September 13–15.
1894	January 24	July 1; August 10, 12–15.
1895	February 2, 4, 5, 7, 8	None.
1896	None	July 27, 31; August 3–9, 14, 15, 21.
1897	January 26–28	July 7–9, 31; Aug. 1, 3, 26; Sept. 3.
1898	None	None.
1899	Jan. 27, 29–31; Feb. 8–13; Dec. 15	Aug. 3, 8, 9, 11, 12, 20, 23, 26; Sept. 4–7.
1900	February 17	August 21.
1901	December 14, 15, 17–20	June 20, 21, 25, 29; July 3, 4, 9–14, 16–24; August 2, 3, 25.
1902	Jan. 26, 27; Feb. 2, 4; Dec. 26	None.
1903	February 17; December 13, 26	None.
1904	January 25, 26, 29; December 27, 28	None.
1905	Jan. 14, 15, 24–26; Feb. 2, 3, 12–15	None.
1906	February 5	None.

TABLE 4.—*Dates of killing frosts at Springfield, Mo.*

Year.	Last in spring.			First in autumn.		
	Mar.	Apr.	May.	Sept.	Oct.	Nov.
1888	.....	.....	14	.....	3	.....
1889	.....	.....	3	.....	6	.....
1890	.....	1	.....	.....	14	.....
1891	.....	4	.....	.....	7	.....
1892	.....	15	.....	.....	9	.....
1893	.....	23	.....	.....	15	.....
1894	.....	.....	19	.....	8	.....
1895	.....	*21	.....	30	.....	.....
1896	.....	3	.....	.....	18	.....
1897	.....	17	.....	.....	29	.....
1898	.....	6	.....	.....	17	.....
1899	.....	9	.....	.....	29	.....
1900	.....	13	.....	.....	.....	1
1901	.....	18	.....	.....	14	.....
1902	.....	8	.....	.....	.....	26
1903	.....	3	.....	.....	.....	6
1904	.....	13	.....	.....	23	.....
1905	.....	16	.....	.....	21	.....
1906	.....	*30	.....	.....	10	.....

* Last freezing temperature.

TABLE 5.—*Precipitation, from Report of Missouri Rainfall.*

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Annual.
1877	.....	1.15	4.76	6.95	8.55	15.20	2.45	6.60	1.90	7.95	4.75	3.20	.....
1878	1.99	2.07	3.27	6.04	7.25	5.19	4.86	4.43	1.05	3.00	0.52	1.92	41.59
1879	1.82	0.66	1.40	2.64	2.59	2.85	1.18	1.50	0.68	0.97	4.62	4.15	25.06
1880	0.87	2.97	2.58	5.10	4.20	4.05	4.50	.....	.....	2.00	3.05	0.80	.....
1882	2.65	7.29	3.19	3.71	8.07	2.70	4.98	2.14	4.48	7.62	6.30	2.30	55.43
1883	1.05	5.65	1.68	3.11	7.30	.....	.....	.....	.....	.....	.....	.....	.....
1884	.....	.....	.....	.....	5.48	2.67	9.22	3.17	3.80	1.73	3.03	7.62	.....
1885	2.80	1.05	2.10	5.01	3.29	5.15	9.14	3.73	6.15	1.75	2.05	1.50	43.72
1886	1.55	3.43	1.50	2.90	9.30	.....	1.75	2.60	3.40	0.40	.....	0.75	.....
1887	2.60	4.10	2.50	2.80	4.60	6.65	2.63	3.29	2.43	2.08	3.27	2.39	39.34

areas of high pressure that develop over the plains of the far Southwest and move toward the middle Mississippi Valley. Rising temperature, increasing southerly winds, and rain, may be expected from a barometric minimum from this quarter, followed by cooler weather, northerly winds, and clearing skies, as the high pressure area becomes the controlling factor.

Thunderstorms are of frequent occurrence during the spring and summer months, and are one of the most prolific sources of rainfall during this season. They are, for the most part, coincident with the approach of low barometric areas from some western quarter, and are rarely of local origin.

The prevailing weather during the crop season, i. e., March to September, inclusive, is eminently favorable to agricultural pursuits. During this period the temperature for the past nineteen years has averaged 65.5°, and the precipitation, 31.29 inches. These figures, reinforced by the fact that ample sunshine occurs, exhibit an ideal condition for the germination, growth, and maturity of all crops.

HYTHERS AND THE COMPARISON OF CLIMATES.[1]

By Mr. W. F. TYLER, F. R. Met. Soc., Coast Inspector, in charge of the meteorological affairs of the service of the Imperial Maritime Customs. Dated Shanghai, China, January 4, 1905.

I have read the pamphlet "Some Climatic Features of the Arid Regions" with great interest and also the papers by Harrington and Pague to which you referred me.

By far the most instructive article is that in the MONTHLY WEATHER REVIEW for August, 1898, on the "comfort curve" ("Sensible temperatures or the curve of comfort", August, 1898, p. 362). In that article the problem that is indicated is: "What function is ideal weather of temperature, humidity, and wind force?"

This problem, dealing as it does with a three-variable function, is necessarily very difficult, the more so that wind force does not appear to be an elemental factor in the total subjective effect of climate as are temperature and humidity.

[1] The editor regrets that this interesting letter was mislaid and has so long remained unpublished. See the Monthly Weather Review, May, 1904, Vol. XXXII, p. 217. Readers interested in the subject will perhaps make use of the following bibliography:

Osborne, J. W. On a new meteorological instrument. Proc. Am. Asso. Adv. Sci., Detroit meeting, 1875.

Pague, B. S. Sensible temperatures, or the effect of heat on the body in California. July, 1895. Reprint in Am. Met'l. Jour., Oct., 1895, p. 196–198.

Harrington, Mark W. Sensible temperatures. Read before the Am. Climatological Asso., May, 1894. (Abstract in Am. Met'l. Jour., July, 1895, p. 93–95.) Intern. Med. Mag., Aug., 1894.

Ward, R. DeC. Sensible temperatures. Bull. Am. Geog. Soc., March, 1904.

Phillips, W. F. R. Sensible temperature. Trans. Am. Climatological Asso., 1896, Vol. 12, p. 16–25.—*C. A.*